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A New Species of *Collyria* Schiødte (Hymenoptera: Ichneumonidae: Collyriinae), a Parasitoid of *Cephus fumipennis* (Hymenoptera: Cephidae) in China, and Potential Biological Control Agent for *Cephus cinctus* in North America

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ABSTRACT: A new species, ***Collyria catoptron***, is described from Gansu Province, China. It is an egg-larval koinobiont parasitoid reared from *Cephus fumipennis*, a grass-mining sawfly that attacks wheat. ***Collyria catoptron*** is currently being evaluated as a possible biological control agent for *Cephus cinctus* in North America.

KEY WORDS: *Collyria catoptron*, Ichneumonidae, *Cephus* spp., wheat stem sawfly, China, biological control

The wheat stem sawfly, *Cephus cinctus* (Hymenoptera: Cephidae), is the most widespread and consistently important insect pest attacking wheat in the northern Great Plains (Morrill, 1995). Larvae feed inside the stems of wheat, weakening the stem and impairing nutrient and water transport. Damage from sawfly larvae reduces yield, lowers grain protein content, and increases operational costs due to fallen stems. Yield reductions to individual stems range from 10 to 22% (Holmes, 1977) with annual yield losses estimated at $25 million in Montana (Montana State University, 1996) and perhaps $100 million in the US and Canada.

Several classical biological control programs have targeted the wheat stem sawfly (Shanower and Hoelmer, 2004). These programs utilized parasitoids from *Cephus pygmaeus* collected in Europe (Hoelmer and Shanower, 2004). *Collyria coxator* (=*calcitrator*) (Hymenoptera: Ichneumonidae, Collyriinae) was identified as the most promising potential biological control agent (Salt, 1931), and large numbers were imported and released in western North America. This parasitoid failed to establish, possibly due to the unsuitability of the host, climatic intolerance, and/or lack of synchronization between host and parasitoid (Shanower and Hoelmer, 2004). The desirability of improving biological control of *C. cinctus*, and the success of classical biological control for *C. pygmaeus* in eastern North America (Filipy *et al.*, 1985) has led to a renewed effort to find effective and adapted natural enemies.

The search for new and effective wheat stem sawfly natural enemies is focused on Asia. A recently proposed synonomy of *C. cinctus* with *C. hyalinatus*, a grass-feeding species inhabiting eastern Russia, Mongolia, northern China and perhaps the Korean peninsula (Ivie and Zinovjiev, 1996), supports the focus on foreign exploration for wheat stem sawfly natural enemies in Asia. As part of our field work in China, a new species of *Collyria* was discovered parasitizing *Cephus fumipennis*,

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Table 1. *Collyria catoptron* parasitism of *Cephus fumipennis* at different locations near Lanzhou, Gansu Province, China (1999).

County, Township	Pre-diapause dissections					Post-diapause emergence		
	Sawfly larvae dissected (#)	Parasitized		Superparasitized[1]		Sawflies	Parasitoids	
		(#)	(%)	(#)	(%)	(#)	(#)	(%)[2]
1. Yuzhong, Shanjiaocheng	64	9	14.1	–	–	199	14	6.6
2. Yuzhong, Ganchao	25	8	32.0	–	–	51	7	12.1
3. Yuzhong, Xiaokangying	24	12	50.0	–	–	8	6	42.9
4. Yuzhong, Chengguan	13	8	61.5	–	–	3	5	37.5
5. Gaolan, Shidong	51	10	19.6	–	–	81	2	2.4
6. Gaolan, Shuifu	66	7	10.6	1	14.3	515	6	1.2
7. Yangdeng, Liancheng	34	10	29.4	1	10.0	84	35	29.4
8. Yangdeng, Heqiao	90	17	18.9	–	–	78	8	9.3
9. Yuzhong, Heping, Qijiapo	23	6	26.1	–	–	25	10	28.6
10. Yuzhong, Heping, Mudanyuan	28	12	42.9	3	25.0	40	25	38.5
Total	418	99	23.7%	5	17.2%	1084	118	9.8%

[1] Superparasitism was observed in more than three samples but was only recorded from samples 6, 7, and 10. As many as four supernumeries were observed in a single sawfly larva.

[2] Percentage of emerged adults that were *Collyria catoptron* (= # adult parasitoids / # adult parasitoids + # adult sawflies).

a sawfly that attacks wheat in parts of China. This manuscript describes the new species and provides notes on its biology.

Collyria, the sole genus in the subfamily Collyriinae, consists of eight species distributed throughout the Holarctic (Yu and Horstmann, 1997). The sole Nearctic species, *coxator* (Villiers), is introduced from the Palearctic (Carlson, 1979). Collyriines are solitary koinobiont endoparasitoids of Cephidae (Salt, 1931).

Materials and Methods

Field collections were made at ten locations in Gansu Province, China within 150 km of the capital Lanzhou from 21–22 September 1999. Wheat stubble was collected from spring wheat fields that had been harvested in July. These fields are typically relay planted with corn (i.e., corn is planted 4–6 wk after planting wheat) or replanted with vegetable crops after wheat harvest. Sawfly infested wheat stubble, referred to as ''stubs'' after being cut by the sawfly larva, was collected from fallow fields and fields planted to corn or vegetables.

Approximately 2500 infested wheat stubs were collected, cleaned, and sent to the Montana State University quarantine laboratory. A minimum of 50 stems were opened from each location, and the sawfly larvae removed and placed in 80% ethanol. Larvae were dissected under a stereo microscope and all parasitoid material removed, including cast-off head capsules. The number of larvae dissected ranged from 13–90 among the ten locations (Table 1).

The remaining stubs were held at low temperatures (~5° C) for three months to simulate overwintering conditions. This material was removed to ambient laboratory conditions the following spring. Each day between two and 11 stubs were opened and the contents placed in 80% ethanol. A total of 241 stubs containing sawfly larvae were obtained and the larvae dissected during the first 33 days to obtain the later

instars of *C. catoptron*. The remaining stubs were held for emergence and the numbers of sawflies and parasitoids recorded.

The morphological terminology is mostly that of (Townes, 1969). *Epicnemial carina* is used for ''prepectal carina'', *gena* for ''temple'', *malar space* for ''cheek'', *supraclypeal area* for ''face'', and *trochantellus* for ''second trochanter.'' *Mesosoma* and *metasoma* are used to refer to the apparent thorax and abdomen, respectively. *T1*, *T2*, etc., are used for the first metasomal tergite and following tergites and *S1*, *S2*, etc. for the first metasomal sternite and following sternites. Reference to the orientation of the various parts of the body follows (Townes, 1969), in that the legs are considered to be stretched out horizontally at right angles to the body.

Specimens are deposited in the American Entomological Institute, Gainesville, Florida, U.S.A. [AEIC], Academia Sinica, Institute of Zoology, Beijing, People's Republic of China [IZAS], and the Chinese Academy of Agricultural Sciences, Beijing, People's Republic of China [CAAS].

Collyria catoptron Wahl, new species

DIAGNOSIS: *Collyria catoptron*, *coxator* (Villers), and *orientator* Aubert may be distinguished from the other species in the genus by: 1) the occipital carina meeting the hypostomal carina at nearly a right angle, and 2) the epicnemial carina having a median low triangular elevation. The following characters will differentiate *catoptron* from *coxator* and *orientator*. The supraclypeal area of *catoptron* is rugosopunctate (Fig. 7) (punctate in *coxator* and *orientator* (as in Fig. 8)). The central portion of the mesopleuron of *catoptron* is usually rugosopunctate, with the rugae oriented dorso-ventrally (Fig. 1), while *coxator* and *orientator* are either simply punctate or with the rugae oriented more or less transversely (Figs. 3–4); specimens of *catoptron* with the rugae more or less absent have distorted punctures (Fig. 2), in contrast to the circular punctures of the other species. *C. catoptron* has the ovipositor shorter than that of *coxator* (0.9× as long as the hind tibia vs. 1.0–1.3×). With respect to *orientator*, *catoptron* has the median longitudinal carinae parallel (Fig. 5) (vs. slightly convergent anteriorly in *orientator* (Fig. 6)).

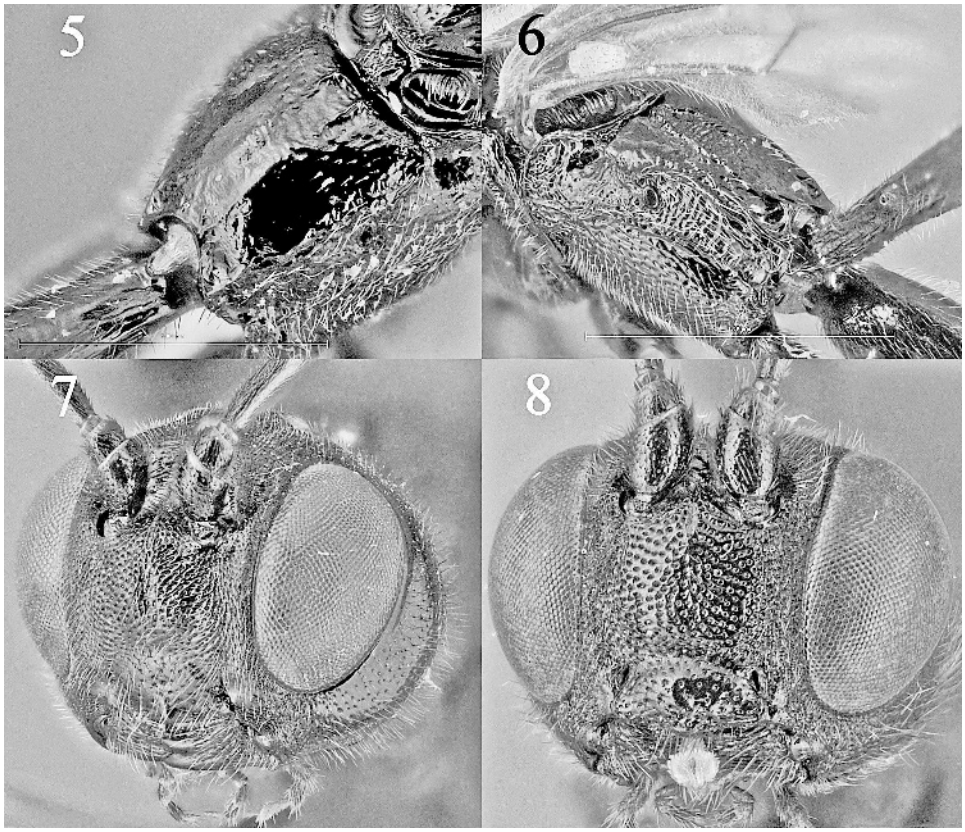
DESCRIPTION: **Female**. *Structure*. Setae of eye inconspicuous and sparse. Clypeus lenticular, about as long as wide; apical margin reflexed and coarsely punctate, with median denticle; remainder smooth and punctate, medially with punctures separated by 0.7–1.0× their diameter. Supraclypeal area rugosopunctate, punctures confluent to separated by about 0.5× their diameter (Fig. 7). Mandibular teeth of equal length. Malar space about 0.5× basal mandibular width. Occipital carina intersecting hypostomal carina at nearly right angle, carinal juncture separated from mandibular base by about 0.8× basal mandibular width. Antenna with 19–22 flagellomeres. Gena smooth and punctate, punctures separated by 0.5–1.0× their diameter. Epicnemial carina with median low triangular elevation. Central area of mesopleuron below subalar prominence rugosopunctate, rugae more or less oriented longitudinally (Fig. 1); if rugae weak or absent, then punctures distorted (Fig. 2). Metapleuron with dorsal 0.5 rugosopunctate, rugae transverse. Propodeum without transverse carinae; median longitudinal carinae parallel, posterior 0.5–0.7 evanescent or absent; lateral areas smooth, with sparse shallow punctures and mostly lacking distinct rugulae, giving an overall smooth and polished appearance (Fig. 5). T1 2.3–2.8× as long as wide; carinae lacking; spiracle at about basal 0.4; surface polished, with fine punctures separated by 1.0–3.0× their diameter. Ovipositor about 0.9× as

Figs. 1–4. Mesopleura of *Collyria* spp. Scale bar = 1.0 mm. 1, 2. *C. catoptron*. 3. *C. coxator*. 4. *C. orientator*.

long as hind tibia. *Color*. Head and mesosoma (excepting legs) black except for: dark brown of mandibular apex, and paraocular region immediately ventral to antennal socket; brownish yellow of ventral surface of flagellum. Coxae and trochanters black. Remainder of fore and middle legs brownish yellow except for dark brown ventral surface of femur. Hind leg with trochantellus, base and apex of femur, basal 0.3–0.5 of tibia, brownish yellow; apical 0.5–0.7 of tibia, and tarsus, brown. Wings clear. Metasoma reddish brown; basal 0.3–0.7 of T1, T7–8, and S1, dark brown. *Length*. 6.4–10.0 mm (9.9 mm); fore wing 4.5–6.8 mm (6.4 mm).

Male. Unknown.

TYPE MATERIAL: Holotype ♀, PEOPLE'S REPUBLIC OF CHINA: *Gansu*, Yuzhong Co., 7–8.ix.1998, T. Shanower - K. Hoelmer - Songbi Chen - Liu Aiping [AEIC]. Condition of holotype: intact. Paratypes: PEOPLE'S REPUBLIC OF CHINA: *Gansu*: 1♀, Gaolan Co., coll. 24.viii.2002, emerg. 27.vi.2003; 1♀, Gaolan Co., coll. 24.viii.2002, emerg. 3.vii.2003; 1♀, Yangdeng Co., coll. 24.viii.2002, emerg. 20.vi.2003; 1♀, Yangdeng Co., coll. 24.viii.2002, emerg. 6.vii.2003; 19 ♀♀, Yuzhong Co., 7–8.ix.1998, T. Shanower - K. Hoelmer - Songbi Chen - Liu Aiping; 31 ♀♀,



Figs. 5–8. Propodea and heads of *Collyria* spp. Scale bar = 1.0 mm. 5. *C. catoptron*. 6. *C. orientator*. 7. *C. catoptron*. 8. *C. coxator*.

Yuzhong Co., coll. 26–28.vii & 28.viii.2004, emerg. vii.2005; 5♀♀, Chengguan township, coll. 12.x.2002, emerg. 25.vi.2003 & 30.vi.2003; 4♀♀, Chengguan township, coll. 19.x.2002, emerg. 16.vi.2003 & 7.vii.2003; 8♀♀, Ganchao township, coll. 12.x.2002, emerg. 19.vi.2003 & 24.vi.2003; 4♀♀, Ganchao township, Houjiagou village, coll. 13.x.2002, emerg. 23.vi.2003 & 29.vi.2003; 2♀♀, Shanjiaocheng township, Lanzhou city, coll. 21.viii.2002, emerg. 14.vi.2003 & 23.vi.2003; 5♀♀, Xiokangying township, coll. 14.x.2002, emerg. 16.vi.2002 & 7.vii.2003 [AEIC, IZAS, CAAS].

Notes: *C. catoptron* will key out to the *coxator* and *orientator* couplet of the key in Izquierdo Moya and Rey del Castillo (1984). In addition to the characters listed in the diagnosis, the following color characters should be noted: 1) *C. coxator* has the hind tibia and tarsus often completely dark brown, and the metasoma often has T1 dark brown and extensive brown highlights on T2–6; 2) *C. orientator* has the hind leg beyond the trochanter dark brown, and the metasoma dark brown except for the apical 0.3 of T1, and T2–3.

With the exceptions of *fuscipennis* (Kriechbaumer) and *sagitta* Kuzin, all species of *Collyria* have been examined as part of a study of their relationships (Wahl, in prep.) The holotype of *fuscipennis* was recorded as missing by Townes *et al.* (1965) and has not been found since then. Dr. Alex Rasnitsyn kindly looked for the holotype of

Fig. 9. Early instar larva of *Collyria catoptron*.

sagitta in Moscow and was unable to locate it. With respect to these two species: 1) *fuscipennis* is overall black in color, T2–4 have reddish apices, and the wings are slightly smoky (Kriechbaumer, 1894), and 2) *sagitta* has the gena striate with dense punctures (Izquierrdo Moya and Rey del Castillo, 1984).

Color variation in *catoptron* is as follows: the middle tarsus is sometimes brown, and T6 is sometimes dark brown. The reddish brown of the metasoma is sometimes darkened due to discoloration by internal oils.

ETYMOLOGY: The specific name is a noun in apposition; it is from the Greek *katoptron*, mirror, in reference to the overall smooth and polished appearance of the dorsal surface of the propodeum.

Results and Discussion

Pre-diapause larval dissections revealed large differences in sawfly parasitism rates by *C. catoptron*, from 10 to more than 60%, among the 10 locations sampled

(Table 1). Overall parasitism was approximately 24%. *Cephus fumipennis* parasitism rates of 10 to 50% have been reported in other studies from China, summarized by (Chen *et al.*, 2004). These earlier studies identify *Collyria coxator* (=*calcitrator*) as the ichneumonid parasitoid attacking *Cephus fumipennis* in China. Based on the results reported here it seems likely that these earlier reports were misidentifications.

Two types of *Collyria catoptron* larvae were found in sawfly larvae, consistent with its heteromorphic development. The smaller, early instar has a heavily sclerotized head capsule, with sharp protuberances projecting from the lateral portions of the body. The head capsule includes large, sharp mandibles (Fig. 1). (Salt, 1931) provides a detailed description and drawings of the larval morphology of *Collyria coxator* (=*calcitrator*). *Collyria catoptron* larval morphology appears similar. The heavily sclerotized head capsules are found on the 1st and 2nd instar. The second larval form was a large, blunt, typically hymenopteran body type which lacks a sclerotized head capsule.

Most parasitized sawfly larvae contained only one *C. catoptron* larva, though 2 or more parasitoids were observed in at least 17% of the sawfly larvae dissected (Table 1). The percentage of superparasitized larvae was enumerated from only three samples (128 larvae) but appeared to be at least as great in the other samples dissected. The majority of superparasitized larvae contained two parasitoids though a small portion (~5%) had three supernumeries, and at least one sawfly larva contained four parasitoid larvae.

Collyria catoptron larvae were found throughout the sawfly larva, though the majority were located in the anterior portion of the host body. Occasionally the parasitoid head capsule was visible through the sawfly larval integument, often when more than one parasitoid was present.

Parasitism rates based on the number of adults emerging following diapause were much lower than indicated by larval dissections (Table 1). Parasitism levels observed in the post-diapause larval dissections, 241 larvae over 33 days, was very similar to the level observed in the pre-diapause dissections (26%, data not shown vs. 23.7%, Table 1). Locations 3, 4, 7, 9 and 10 had similar parasitism rates while the other locations had parasitism rates measured by adult emergence that were substantially lower than the larval dissections indicated. There may be several reasons for the lower parasitism rates calculated from adult emergence numbers. Overwinter mortality may be higher for parasitized sawflies than for unparasitized sawflies. Also, the trauma of collection, transportation and laboratory rearing may have adversely impacted parasitoid survival.

The only organisms to emerge from the sawfly-infested wheat stems were *Cephus fummipennis* and *Collyria catoptron*. No other sawfly natural enemies were observed in this or in subsequent shipments. The sex ratio of *Collyria catoptron* is highly female biased. All of the individuals that emerged in this study were females.

Collyria catoptron is currently being evaluated for its suitability and efficacy as a biological control agent for *Cephus cinctus* in North America.

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Literature Cited

Carlson, R. W. 1979. Family Ichneumonidae. In: K. V. Krombein, P. D. Hurd, D. R. Smith, and B. D. Burks (eds.). *Catalog of Hymenoptera of America North of Mexico 1*, pp. 315–741. Washington, DC. Smithsonian Institution Press.

Chen, S., K. A. Hoelmer, H. Chen, A. Liu, and T. G. Shanower. A review of wheat stem sawfly (Hymenoptera: Cephidae) research in China. Journal of Agricultural and Urban Entomology 2(4)1:249–256.

Filipy, F. L., P. P. Burbutis, and R. W. Fuester. 1985. Biological control of the European wheat stem sawfly in Delaware (Hymenoptera: Cephidae). Environmental Entomology 14:665–668.

Gauld, I. D., and B. Bolton. 1988. The Hymenoptera. British Museum (Natural History) and Oxford University Press, New York. 332 pp.

Hoelmer, K. A., and T. G. Shanower. 2004. Foreign exploration for natural enemies of cephid sawflies. Journal of Agricultural and Urban Entomology 21(4):223–238.

Izquierdo Moya, I., and C. Rey del Castillo. 1984. Sobre las especies de *Collyria* Schiödte, 1839 (Hym., Ichneumonidae). Eos 60:55–65.

Kriechbaumer, J. 1894. In: Sickman, F. (ed.). ''Beiträge zur Kenntniss der Hymenopteran-Fauna des nördlichen China'', pp. 197–198, Zoologische Jahrbücher Abteilung für Systematik 8(1895): 195–236.

Montana State University. 1996. Special issue: Wheat stem sawfly. Montana Crop Health Report, Sept. 9, 1996 9(11):1–7.

Morrill, W. L. 1995. *Insect pests of small grains*. APS Press, St. Paul, Minnesota. 140 pp.

Salt, G. 1931. Parasites of the wheat stem sawfly, *Cephus pygmaeus* Linnaeus, in England. Bulletin of Entomological Research 22:479–545.

Shanower, T. G., and K. A. Hoelmer. 2004. Biological control of wheat stem sawflies: Past and future. Journal of Agricultural and Urban Entomology 21(4):197–221.

Townes, H. 1969. The genera of Ichneumonidae, part 1. Memoirs of the American Entomological Institute 11:1–300.

Townes, H., S. Momoi, and M. Townes. 1965. A catalogue and reclassification of the eastern Palearctic Ichneumonidae. Memoirs of the American Entomological Institute 5:1–661.

Yu, D. S., and K. Horstmann. 1997. A catalogue of World Ichneumonidae (Hymenoptera). Memoirs of the American Entomological Institute 58:1–1558.